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RELATIONSHIP BETWEEN CHEWING AND BRAIN ACTIVITY

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ABSTRACT

Modern studies have suggested a positive correlation between the process of chewing, medically known as mastication, and brain function. The major brain parts associated with mental activity are the hippocampus and prefrontal cortex, which are integral for memory and learning. Regarding this relationship, declined mastication causes dysfunction of brain parts. Reduced mastication produces the degeneration of hippocampus neurons, leading to the risk of the development of dementia and increasing the probability of having Alzheimer's disease. The declining process generally happens to old people undergoing teeth loss, salivary defect, or motor impairment. This paper indicates several in-depth research studies and the results derived from epidemiologists, as well as additional researchers from various fields on both the negative and positive effects of mastication on brain activity.

KEYWORDS: Chewing, Brain Function, Memory, Learning, Hippocampus, Alzheimer's

INTRODUCTION

Epidemiological studies have indicated that "aged individuals with fewer teeth and slower mastication are more likely to undergo cognitive dysfunction since the function of the hippocampus and prefrontal cortex, which are the essential parts of brain development, would not be able to perform their job" (Chen et al., 2015). The deteriorated function of these parts would reduce critical thinking ability and cause ramifications either in forming new memories or remembering old ones. "Residual teeth are lost due to the aging process. The loss of teeth then leads to the decline of biting force, which is directly affecting the worsened dementia" (Kubo et al., 2015). Similarly, reduced biting force indicates a lower frequency of mastication available for an individual, and slow mastication occurs delaying dementia. Not only does the process of chewing affect the brain, but also the chewing frequency does, as previously mentioned. "Cerebral oxygenation, which is dependent on the arterial blood, cerebral blood flow, etc is generated during the process of chewing, and mastication facilitates the blood to maneuver to the brain. As a result, cerebral oxygenation increases the cerebral activation (Yokoyama et al., 2016)". Unfortunately, the lack of oxygen in the brain can cause coma or seizure when malicious; hence, it is important to prevent this by maintaining the frequency of chewing regardless of the consequences for an individual.

LITERATURE REVIEW

The brain is located at the top of our head, inside the skull and the mouth is located at the bottom center of our face. The two distinct necessary parts of our body possess strong associations regardless of their physically distant location. Their interaction initially began with a short question: "Does chewing gum relieve stress?". Researchers have been working on the reason why people felt free from their stress while chewing gum and have observed a strong conclusion: it was the process of chewing rather than the gum itself that relieved the stress. The process of chewing the gum creates salivation, and swallowing this salivation carries oxygen to the brain; this allows an individual to feel calm and relaxed. This conclusion has become the foundation of the studies on the relationship between mastication and brain activity and has enabled researchers to begin an in-depth study on this impact. Throughout the complex research process, researchers have figured out the positive and negative impacts of mastication when it either inclines or declines. When mastication is increased, it uplifts brain activity; conversely, it reduces brain activity by deteriorating mental skills when decreased. This process of decline is one of the main causes of Alzheimer's disease, which is a progressive disease happening due to low dementia. Individuals with this mental disorder will experience mild memory loss, communication issues, or loss of cognition ability. The process of mastication impacts the brain through various paths in our body.

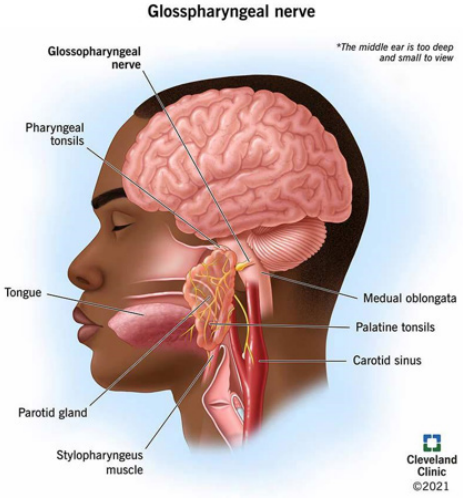


Diagram showing the anatomical location of the brain and the mouth in the human body

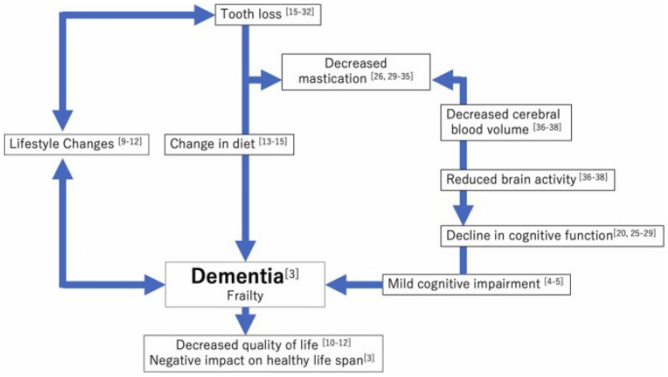


Diagram demonstrating the relationship between mastication and cognitive function

Correlation of Mastication and Brain Activity

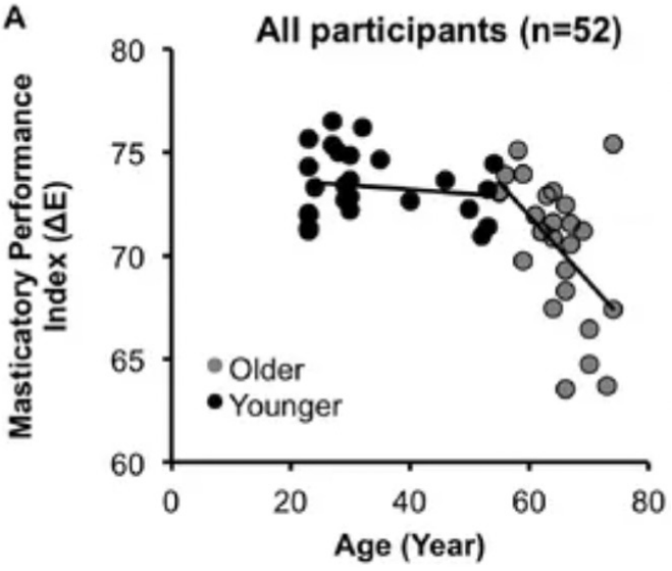
Evidence suggests that the process of chewing supports brain activity by sending countless pieces of information received from the mouth to different parts of the brain region, enabling the activation of mental processing. Thus, this cycle is not always successful. Individuals with lost teeth experience occlusal disharmony, causing chronic stress and resulting in fatal changes in the brain. One of the main parts of the brain that gets affected is the hippocampus: the essential brain part for memory and cognitive functioning. Mastication can affect the hippocampus in various neural pathways, but mainly the sensory information would be collected in the oral cavity, which includes teeth. The collected message would be transmitted through the trigeminal sensory nerve—the nerve that connects the neurons from the face, nose, mouth, etc.—to the hippocampus. The message can even reach further to the cerebellum or reticular formation, as these parts are located back and next to the hippocampus, respectively. Likewise, the teeth play an essential role in information communication. The National Library of Medicine demonstrated this via a European population-based cross-sectional study on the importance of natural teeth for hippocampus-based cognitive processes. The team was observing whether the participants could memorize episodic long-term memory clearly regarding the frequency of mastication. As a result, the conclusion stated that chewing increased the blood flow and decreased the rate of cognitive impairment. Even though this experiment strengthens the relationship between mastication and hippocampus, the relationship cannot always be positive. Acknowledging the fact of a positively correlated relationship, when mastication dysfunction worsens, the risk of dementia increases. The National Library of Medicine experimented to distinguish the clear link between masticatory dysfunction and cognition by using three different animal models. Each group either made mammals remove their teeth at the back of their mouth, known as molar teeth extrication, reduce the cap size of the mammals' teeth, medically named crown reduction, or match the mammal's upper and lower teeth, a process called the bite elevation. Overall, the purpose was to observe their chewing frequency and their effect on the hippocampus. This observation revealed that animals were overall able to chew, but when the frequency declined, it led to the diminished spatial learning ability of animals. The group of animals with a lower frequency rate had poor spatial ability, which prevented them from recalling memories.

Experiment and the Result

The R.A.F. Wejinberg and F. Lobbezoo indicated the association between cognition and mastication throughout an experiment. They aimed to record the altering attention individuals possessed depending on the chewing frequency. Two researchers randomly selected participants and made them chew gum without telling them the reason. All of the gums did not have any flavor to prevent the compound variable. Some individuals had higher frequency than others, while other individuals had lower frequency. The outcome demonstrated that a participant with active mastication had better attention than the other with lower frequency, which leads to the point where the higher chewing rate can improve an individual's cognition, such as working memory and subjective alertness. Despite these positive facts, deterioration of mastication is inevitable. The mouth of an individual becomes dry when they age. This enables bacteria to live inside an individual's mouth, increasing the possibility of tooth decay. Not even tooth decay; the aging process causes the loss of teeth as the gums can no longer support the teeth tightly. This inevitable process also prevents mastication organs such as bones, muscles, teeth, and soft tissues from performing their own assigned job. On the whole, the aging process generates factors that cause the reduction of mastication and worsening dementia.

CONCLUSIONS

In respect of various proven results of conducted experiments, mastication and brain activity are positively related. When mastication is frequent, it enhances memorization and critical thinking skills by activating different brain regions such as the hippocampus and prefrontal cortex. On the other hand, when the process decelerates throughout the aging process, brain region dysfunction occurs. This then leads to increased chances of Alzheimer's disease or other mental disorders due to lack of oxygen and increased possibilities of malicious factors produced through mastication.



Graph demonstrating a relationship between the age and Masticatory Performance Index (MPA), as the age increases, the MPI decreases thus showing negative correlation.

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